THE INSECTS OF THE SOYBEAN IN OHIO

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[1]In cooperation with the College of Agriculture, Ohio State University, Columbus.
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BULLETIN
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THE INSECTS OF THE SOYBEAN IN OHIO

W. V. BALDUF

INTRODUCTION

The rapidly growing importance of the soybean as a farm crop in Ohio, and in other states as well, suggested the need of investigation to determine the liability of this legume to attack by insect pests. Weekly collections were, therefore, made in fields located chiefly around the Washington County truck experiment farm near Marietta during the summers of 1919, 1920, and 1921. In a general way these studies confirmed the common claim that soybeans are comparatively free from injurious insects, even though two hundred and nine species were collected on the crop and on the vegetation in the immediate surroundings during the three years. Of this large number, several are capable of inflicting notable harm under favorable conditions, and others are significant factors as parasites and predators in keeping the potential pests at minimum numbers. It is the purpose of the first part of this paper to present discussions of these chief species. The remaining forms are of interest mainly from the standpoint of their food and developmental relation with the weeds and grasses of the field borders and the crop itself, and will be given separate space in the latter portion of this article.

I. THE MORE IMPORTANT INSECTS ASSOCIATED WITH THE SOYBEAN

GRASSHOPPERS

While the green clover worm is the only insect that deserves to be ranked as a general pest of soybeans in this country, there is probably more danger to soybeans in occasional seasons in Ohio from the feeding of grasshoppers. When conditions favor a large number of these insects, and dry summer weather cuts off their

other food supply, they are often found on cultivated crops where much damage may be done. Such conditions occurred at Marietta in 1919.

Several species (*Acridiidae*) were common; but the chief ones were the red-legged grasshopper (Melanoplus femur-rubrum DeG.), the lesser migratory locust (*M. atlanis* Riley), and the differential species (*M. differentialis* Uhl.). The first two, which are often confused, have similar habits. Both are abundant at times.

THE RED-LEGGED GRASSHOPPER AND THE LESSER MIGRATORY LOCUST

These are among the smaller hoppers, but they are usually the most plentiful forms in this State. They are about one inch long, and are not readily distinguished.

They occur (19) everywhere in the United States, in pastures, meadows, and along roadsides and borders of cultivated fields as well as on cultivated crops. The eggs are laid in sodded places during September and October, and the nymphs make their appearance in the spring, about May. Adulthood is reached in latter June or early July. At this time and during August most injury may be expected, for the hoppers are grown, and dry weather may aid in curtailing their wild food supply. The hoppers then attack farm crops, and control measures may be necessary. However, the development of these grasshoppers to injurious numbers may not be expected regularly. The chief reasons for their erratic appearance are the unfavorable winters and the reduction of their numbers by insect enemies and fungous diseases.

THE DIFFERENTIAL GRASSHOPPER

This species is nearly uniform dark brownish green, hind femora dull or bright yellow, hind tibiae yellow, and spines black. Its length varies from one and three-sixteenths inches to one and three-quarters inches, according to sex, the male being the smaller. It is one of the largest common species, and inhabits the Mississippi Valley as far north as the latitude of Ohio and to the Gulf of Mexico, and the region to the west as far as the Pacific. It has essentially the same habits as the red-legged species and is regarded as almost an equal from the standpoint of injury.

There are several other species of grasshoppers found on soybeans, but they will perhaps never become primary economic forms.

For a complete list of grasshoppers taken on this crop see page 162.

Control.—When a crop of soybeans is threatened by grasshoppers, the best remedy is a bran mash, made as follows:

Bran	20	pounds
Paris green	1	pound
Cheap syrup	2	quarts
Water	3.5	gallons

Place the paris green (8) and the bran in a tub and mix thoroughly while dry. Dissolve the syrup in the water and mix this with the poisoned bran, stirring thoroughly. Flavor with three oranges or lemons chopped fine and mixed in the mash. This may be applied broadcast over the infested area, preferably late in the evening or very early in the morning. Poultry should be kept away from treated fields.

LEAFHOPPERS CICADELLIDAE

During the summer, pastures and meadows harbor myriads of small jumping insects that obtain their food by sucking plant juices. There are several species of this kind that invade the soybean field each year. Their habits are very much the same. The nymphs or wingless young are often found along the veins on the under surface of leaves. The adults are found in similar places but are less easily seen because they escape readily by flight or hopping. Most of the abundant and injurious species found on soybeans are greenish, with heads more or less pointed at the front, and with wings forming a roof-shaped cover over the back and tapering toward the posterior.

THE APPLE LEAFHOPPER, *Empoasca mali* LeB.

This leafhopper has attracted wide attention on account of the injury to potatoes known as tipburn. The adult hopper is pale yellowish-green and about one-eighth inch long. It is variously known as the leafhopper of apple, potato, or bean. The adults and nymphs suck juices from the under surfaces of the leaves, at first near the tip, and as the leaf dries and curls under they feed nearer the midrib. As a result the entire leaf turns brown and rolls in extreme cases. The injury resembles the effect of scorching by fire, hence the common name by which it is known. This species of insect was very abundant on the soybeans under observation and accomplished considerable harm to the crop. Leaves were sometimes found turning yellow and wilting at the tips.

The winter is passed in the egg stage on the apple, and the first brood of nymphs develops on this plant. Some of the adults of

later broods migrate to other plants. Doubtlessly eggs are also deposited in the leaves of soybeans since all stages of nymphs may be found on the leaves.

The nymphs on potato and apple may be killed by spraying with "'Black Leaf-40", and on soybeans can probably be checked by the same remedy. However, due to the large acreage of soybeans and the common practice of planting broadcast the difficulty of control will be great should the use of remedies ever be found necessary.

For a list of Cicadellidae (leafhoppers) taken in or about soybean fields, see page 162.

THE TARNISHED PLANT BUG, *Lygus pratensis* L.

This species varies much in appearance. It is about one-fourth inch long. The color of living specimens frequently inclines to olive green. The femora always have two dark bands or rings near their tips. One of the most characteristic marks is a yellow V, sometimes more like a Y, or indicated by three simple dots on the scutellum (a three cornered area on the center of the back).

The tarnished plant bug is more widely known as a pest than almost any other insect. It belongs to the group of sucking insects, and feeds on a great variety of plants, including soybeans. On some cultivated plants it seems to do quite as much injury by the poisonous substance thought to be extruded during feeding as it does by taking juices from the plant. There are several generations a year, and each produces numerous individuals. The total harm to a farm crop may, therefore, be considerable. Yet control of this insect on soybeans will probably never be undertaken, chiefly because such work can have only temporary value, due to the ability of the insect to survive on diverse plants and to migrate readily from one crop to another, it being very active both as nymph and as adult.

THE GRAPEVINE COLASPIS, *Colaspis brunnea* Fabr.

The adult is dull brownish-yellow, oblong oval, and about three-sixteenths inch long. It is among the earliest insects to appear on soybeans. The first individuals were taken in a wheat field June 16, 1921, and on soybeans June 22. They were most abundant from July 12 to August 4, and none were taken after August 11, 1921. Mating was first observed July 12, 1920, and eggs were observed to be laid approximately from July 15 to August 15. Eggs placed in sterilized vials gave rise to larvae nine or ten days

after oviposition. The first larvae hatched about July 25. Therefore, although the life history is not well known, it is probable that the grubs become almost or quite mature before winter, and that the adult state is reached in the latter part of June and in July of the following year.

Soybeans seemed distinctly more attractive than clover and timothy, although the beetle was generally available on the latter plant. It has usually been reported feeding on grape foliage, and also on garden beans and tick trefoil (*Desmodium* sp.). At Marietta, it was found on small clumps of timothy in lanes, rather common in alfalfa, and sparingly in red clover, garden beans, cowpeas, and the foliage of cultivated grapes. Although the wild grape was present on the hillsides and along the Muskingum River, the beetle was not taken on it, probably because these vines were distant from the larval host plant. The larvae feed on the roots of grape, strawberry, corn, and timothy and other grasses. They have done notable injury to roots of corn in Illinois. A biennial or perennial host is not essential for the completion of the life cycle of this species, as it appears that the grubs can develop on annual plants, for example; eggs may be laid on timothy and the larvae reach maturity on corn following it the next year. Its range is over the entire United States and southern Canada east of the Rocky Mountains, and it has been recognized as a moderate pest capable of appearing in great numbers periodically.

Description of The Eggs and Newly Hatched Larvae.—The egg: 0.6mm. long and 0.25mm. thick; light lemon yellow, perfectly smooth, shiny; oval, broadly rounded at ends. The eggs adhere readily to one another. They seem to be normally placed in the soil.

Newly hatched larva: a scant mm. long; head with at least three pairs of spines on each side; thorax with a pair of bristles on each lateral surface, one bristle above the other; each abdominal segment also with such bristles arranged similarly; caudal segment with two additional but shorter spines extending horizontally backward, also a pair of prolegs; mandibles brown, dorsal surface of whole body yellowish.

THE PALE STRIPED FLEA BEETLE, *Systena taeniata* Say.

The pale striped flea beetle is about one-eighth inch long and has a reddish head, brownish thorax, and wing covers marked with two pale yellowish stripes from end to end. It attacks a large variety of garden plants, and was found rather commonly on soy-

beans. The study of the weedy and grassy borders around the soybean fields showed that certain weeds were much preferred to soybeans, but the cultivated crop is also subject to noteworthy attack.

The adult was abroad from June 22 to September 9 at least, the greatest numbers appearing from July 26 to August 8 in 1921. There is probably only one brood a year, and at Marietta the eggs are obviously laid in the latter part of July and throughout August.

The larvae have been found on the roots of Lamb's-quarters, and the presence of the adult on soybeans seems to be due mainly to the proximity of the weed host plant of the larva. The ability of the beetle to jump readily accounts for the distribution from the weeds to the soybeans. This instance and others, disclosed by the study of the relation of weedy borders to the insects attacking a cultivated crop, have clearly demonstrated the importance of preventing the development of weeds around fields.

A spray of bordeaux mixture plus arsenate of lead is most effective against flea beetles. It acts as a repellent. Flea beetles generally avoid poisoned foliage.

THE POTATO FLEA BEETLE, *Epitrix cucumeris* Harris.

This species, which is one of the common garden insects, one of the most populous on soybeans. The adult is one-sixteenth inch or slightly less in length. It is black with browinsh legs and antennae. Solanaceous plants are most subject to attack, and the larvae develop in potato tubers and probably on other hosts. The soybean was found to be a common food plant of the adults. They are also known to subsist on border vegetation. There appear to be two broods from June 22 to August 22, and possibly others developing earlier or later. They were most numerous on soybeans and border plants July 12, 1920 and July 2, 1921. The second brood represented within the above dates was at its height August 24, 1921.

The adult chews small holes in the foliage, and in extreme cases may kill the plants. Injury was not so severe as this on soybeans.

THE TOOTHED FLEA BEETLE, *Chaetocnema denticulata* Ill.

This is another flea beetle that did conspicuous harm by eating small holes in the leaves of soybeans shortly after the plants came up. The largest numbers were present during 1921, July 14 to 26, and the majority were taken from the weeds and grasses around

the soybean field. The infestation obviously originated in these grasses or weeds. The adult is black, larger, and more robust than the potato flea beetle. Its habits are imperfectly known.

THE BEAN LEAF BEETLE, *Cerotoma trifurcata* Forst.

The bean leaf beetle, although about the same length as the striped cucumber beetle, is more robust. The wings are reddish and marked with six black areas.

In the south, this beetle is one of the prominent bean pests. It did minor injury to garden beans at Marietta in the spring, but did not become a pest and the number was reduced distinctly with the advance of the season. As unlimited food and host plants were available, it seems that climate, parasites, or some other factor must have been responsible for its suppression.

One beetle was taken out of the soil April 28, and others were taken on alfalfa May 18, on garden beans May 31, and from soybeans June 4 to 24. They were more prevalent in 1920 than in 1921. In the latter year a few occurred on soybeans from July 14 to September 9.

Eggs were deposited in a cage June 6 and 9. Larvae hatching showed the egg stage to be ten days. One adult was reared from a larva placed on a potted soybean plant.

When control measures are necessary, arsenate of lead is effective as a spray applied especially to the underside of the leaves, where the beetles generally hide and feed.

INSECTS ATTACKING ROOTS AND SEEDS OF SOYBEANS

Although roots of the soybean were examined at times, there was no indication that these parts are the feeding places of either a larval or an adult insect. Neither mature seeds observed in cages for months nor beans fresh from the field showed evidence that weevils were present. The occurrence in the field of a few adults of the common bean weevil (*Bruchus obtectus* Say) suggests that infestation of soybean pods is possible; but these adults may have developed in other kinds of beans, and have migrated to the soybean field. However, the number of weevils taken was so small that infestation was improbable.

THE GREEN CLOVER WORM, *Plathypena scabra* Fabr.

The green clover worm is primarily a pest of red clover, on which it has been more or less an enemy for many years. With the increasing acreage of soybeans, this worm has caused serious losses

by defoliating thousands of acres of the crop in Virginia, North Carolina, and neighboring states, especially in 1919. To date it has been of only minor importance in Ohio, and may not be expected to become a persistent annual pest anywhere. Outbreaks are periodical, being due, apparently, to a favorable combination of extensive food supply, favorable weather especially during the winter, and the absence of insect enemies, mainly parasites.

HISTORY, DISTRIBUTION, AND FOOD PLANTS

Prof. C. V. Riley described the larva and adult in 1867 (3), and suggested means for its control. In 1879, Professor J. H. Comstock (4) stated that the adult had been known for a long time as common in almost every part of the United States, being found from Nova Scotia to Texas, east of the Rocky Mountains.

The legumes are the chief plants attacked, clover being the usual host. It is recorded as feeding on beans and peas (5) around Washington, and on soybeans and lima beans in 1897 and 1899. The wild legumes of the genus *Meibomia*, which are common in uncultivated places, and a species of locust (*Robinia*) (6), were also attacked. More recently it has been cited by different observers as an alfalfa pest of considerable note. The rosaceous plants, strawberry and blackberry, have been occasional hosts.

INJURY AND HABITS

The worm feeds on the foliage and sometimes on the blossoms of the soybean (7). It seems to have a distinct preference for the well expanded leaves near the top. When these have been consumed the younger and older leaves are sometimes attacked to the extent of completely defoliating the plants. When it is disturbed the worm squirms and flips itself in a manner that suggests the action of a fish out of water. But when relieved it makes way hurriedly to its usual feeding place.

The adult or moth is seldom seen in daylight, as it secludes itself on the underside of soybean leaves during the day. Sherman and Leiby (2) state that the moth seems to prefer to hide around sheds and other buildings. When driven from cover in the field, the moth makes a sudden appearance, darts a few paces away, alights and quickly crawls under the leaves.

LIFE STAGES

The egg: transverse diameter nearly 9.5 mm., slightly flattened above, more decidedly so below; whitish, the upper half sometimes dotted with dark brown; upper surface ribbed.

The larva or worm: one and one-sixteenth inches long; head light green; body dark green, with a distinct yellowish longitudinal stripe on each shoulder, and fainter stripes of the same color on the middle of each side; body tapering to the posterior; caudal prolegs prominent; three other pairs of prolegs present, causing a semi-looping action in locomotion. Many minor variations appear in different individuals.

The pupa: length 15 to 16 mm.; greatest diameter about 4 mm.; posterior end bluntly pointed; color medium brown, shiny. The pupa is enclosed in a coat composed of dirt, bits of leaves, and other available particles on the ground under the plants.

The adult: outer wings spread 31 mm.; body length 12 to 14 mm.; antennae or feelers threadlike, 10 to 11 mm.; anterior wings blackish-brown, with a distinct hairy fringe on the back and inner margins, the latter being longer and hairlike; under wing-surfaces almost uniform coppery brown. When in a position of rest the wings assume a deltoid shape.

LIFE HISTORY

Adults were often found alive in the winter (2) under loose dead bark and in like sheltered places. Riley (6), Chittenden, (5) and Coquillet advanced evidence showing that the adults hibernate. They usually seek some protected situation and have been found congregated about barns and haystacks. However, Riley (6) also found the chrysalid under bark in winter in Missouri. There is thus good reason for believing that this insect may pass the winter either as adult or as pupa. Probably those developing to chrysalids late in the fall hibernate in the pupal stage.

The date of their appearance in the spring varies according to latitude and annual differences in temperature. Caterpillars were taken from red clover in May at Marietta, which indicates that the moths came from winter quarters during April.

The field of beans studied in 1919 came up during the first week of June, and a few caterpillars were found there on the 22d. These larvae represented what is believed to have been the second brood, the first having developed on red clover and alfalfa. On July 14 the maximum number was taken. The majority of them were more than half grown. The beans had matured by September 9, and no caterpillars were taken at that time. Their number had gradually decreased from July 14 to September 9, due to the maturing of the host plant and to the completion of the second brood. It is likely that a third brood develops at Marietta because brood two

was already at its climax in the middle of summer. But few, if any of this brood develop on soybeans. These probably feed on other legumes, which are, however, not abundant at this season.

According to Sherman and Leiby (2) the eggs require about five days to hatch in August in North Carolina. The eggs are laid on the foliage of the food plants, and the larvae take about 25 days to develop from hatching to maturity. When fullgrown, they leave the plant, and may often be found on plants which apparently do not serve as food. They crawl under any loose vegetative material on the ground, or may enter cracks in the soil. Here the larva spins a fragile silken cocoon mingled with bits of earth. Eleven days are needed to pass through the pupa stage in midsummer.

NATURAL ENEMIES

Several predaceous and parasitic insects attack the green clover worm at Marietta. One of the social wasps (*Polistes annularis* L.) was seen consuming the larvae or carrying them from the soybean leaves. The most common predators were two species of Robber flies (*Deromyia umbrinus* Loew and *D. discolor* Loew) These were often observed buzzing droningly among the soybeans, searching for their prey, and are known to have eaten these worms on the leaves where they were caught. Another species (*Erax rufibarbis* Mac Quart) was seen occasionally in the soybean field in 1921. In North Carolina (2) an egg parasite (*Trichogramma pretiosa* Riley) was so abundant as to help materially in checking the ravages of this pest, and at Marietta a four winged parasite (*Aleiodes intermedius* Cresson) attacked the small larvae to a slight extent. But the chief internal parasite found at Marietta was the Red-tailed *Tachina* (*Winthemia quadripustulata* Fabr.), reared from worms that were more or less mature. Sherman and Leiby (24) record eight dipterous and hymenopterous parasites reared from this host in North Carolina.

The natural enemies found at Marietta constitute one of the effective factors in keeping this worm from developing to very serious numbers.

REMEDIES

The application of control measures for this worm have never been necessary in Ohio, but the results obtained in experiments by Sherman and Leiby (2) are cited here briefly in order that the grower may have the information for use if occasion should require.

They report very satisfactory control from the use of dust made of lead arsenate, one part by weight, and hydrated lime, eight parts by weight. It was mixed by stirring with a shovel or stick in a box or on a smooth surface. The dust was applied in two ways, (1) by hand, in which case the material was sifted through the fingers while the hand was swung through the tops of the plants, and (2) by the use of a machine of the blower or fan type. This was strapped to the body and operated by a crank, producing a dustcloud. Both methods were effective but more material was required by the hand method. Eighteen pounds of this mixture will check injury on an acre when the soybeans are half grown and in rows. Inasmuch as the applications of dust are made one or two months before harvest, there is evidently no danger of the hay's poisoning stock.

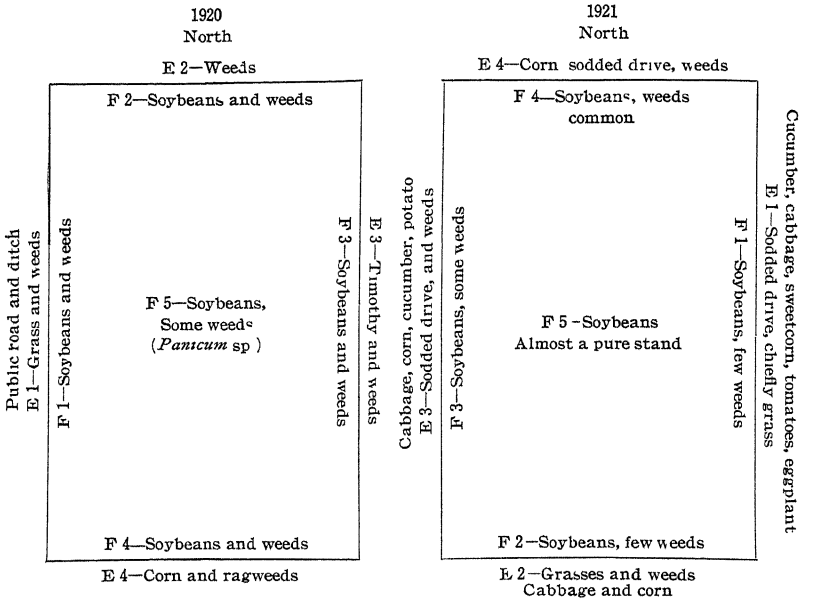
INSECT ECOLOGY OF THE SOYBEAN

When the study of soybean insects was undertaken, the desirability of investigating the effect of environmental weeds and grasses on their kinds and abundance was recognized. Accordingly, weekly sweepings were made in the summers of 1919 to 1921. In the latter two years, the fields chosen were divided into five stations. Four of these consisted of the four margins, each embracing a six foot strip extending the full length or width of the field. The fifth included the general central part located at least five rods from the marginal stations. To determine the number of insects that confine their feeding (1) to soybeans, (2) to the plants growing just outside of the field, and (3) that feed promiscuously in either plant society, the environment of the soybean field was also studied. For this purpose it was divided into four stations corresponding to the four marginal stations. These stations were narrow strips of grasses or weeds, the plants being such as constitute the usual flora along lanes and fences.

DESCRIPTION OF STATIONS

The stations are designated by number, the figure following the letter E for environmental station and following F for field station.

DIAGRAMS OF THE STATIONS STUDIED IN 1920 AND 1921



1920 STATIONS

Station E1.—Plant species present: ragweed *Ambrosia elatior* L.; Canada fleabane (*Leptolon canadense* L.); lamb's-quarters (*Chenopodium album* L.); lady's-thumb (*Persicaria persicaria* L.); and a small amount of grass. Ragweed and lady's-thumb dominated. The south end of this station was much the lower, and more weeds occurred there.

Station E2.—The east end was depressed. Here the common milkweed (*Asclepias syriaca* L.) was fairly common. Other plants were: ragweed, lady's-thumb, evening primrose (*Oenothera biennis* L.), Canada fleabane, and *Aster* sp. This was the weediest place in the entire environment.

Station E3.—The north end was low. A timothy field which was nearly exhausted constituted this station. The crop was allowed to stand several weeks after ripening and was cut July 24. Ragweed and red clover were mixed with the timothy.

Station E4.—The south side of the soybean field was bordered by a corn field. A mass of ragweeds grew to maturity in one place.

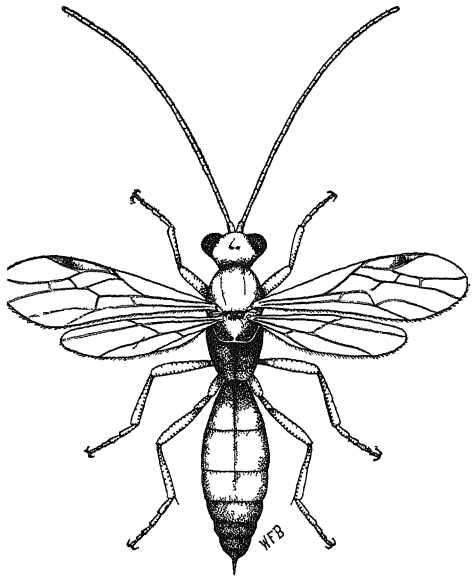


Fig. 1

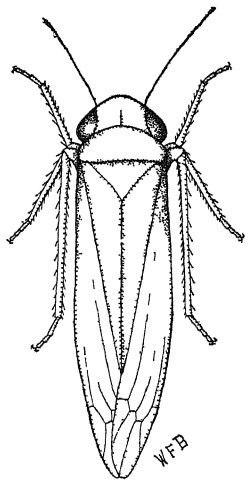


Fig. 2

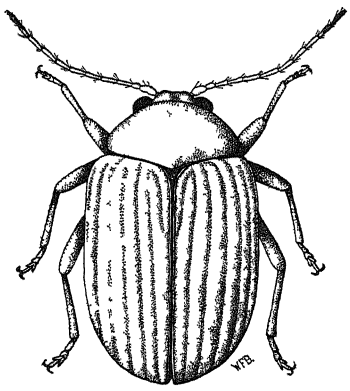


Fig. 3

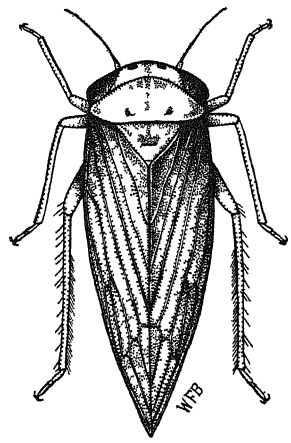


Fig. 4

Fig. 1—Aleiodes intermedius X10
Fig. 2—Empoasca mali X6
Fig. 3—Colaspis brunnea X8
Fig. 4—Agallia constrict X7

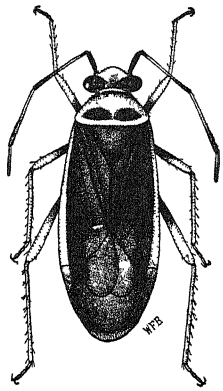


Fig. 5

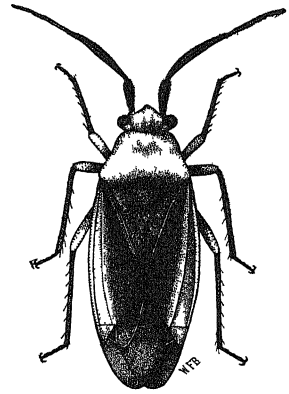


Fig. 6

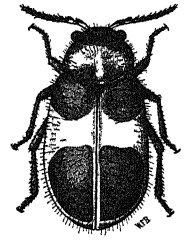


Fig. 7

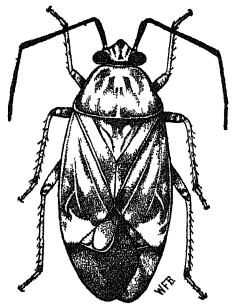


Fig. 8

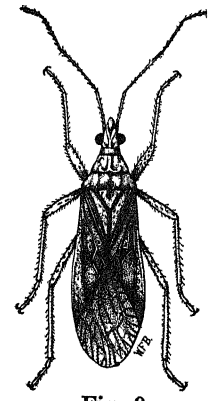


Fig. 9

Fig. 5—Adelphocoris rapidus X5
Fig. 6—Lopidea media X6
Fig. 7—Collaps quadrimaculatus X7
Fig. 8—Lygus pratensis X6
Fig. 9—Nabis ferus X4

Stations F1 to F5.—The stations in the soybean field were at first composed exclusively of soybeans. But due to inadequate cultivation, various weeds appeared. *Panicum* sp., ragweed, and pigweed (*Amaranthus retroflexus* L.) were fairly common in F1, especially close among the beans. The weeds in F2 were chiefly lady's-thumb, which was also present in F3. Associated with it in the latter station were a few ragweeds, and an abundance of panicum. A few ragweeds grew up in F4. Ragweeds, lady's-thumb, and much panicum interfered conspicuously with the growth of soybeans in the general central area of the field or station F5.

1921 STATIONS

Station E1.—Blue grass, red clover, alsike, timothy, *Plantago Rugelii* Dcne., *P. Lanceolata* L., shepherd's-purse (*Capsella Bursa-pastoris* Medic.), morning glory, and other species scattered. The vegetation was cut with a field mower June 30 and August 8.

Station E2.—Grasses and miscellaneous weeds.

Station E3.—Species essentially as in E1. Yarrow (Achillea millefolium L.) in bloom.

Station E4.—Species as in E1 and E3.

Stations F1 to F5.—The soybeans were sown broadcast, and the stand was good. Hence the field was relatively free from weeds, and the insects taken may be regarded as having been swept essentially from the soybeans. Some panicum and lady's-thumb rose above the beans later in the summer.

The number of sweeps for each collection and station, and the number of individuals of each species* were recorded separately. This made possible a study of the relative abundance in the various stations at the different times of the seasons. The fields selected in 1920 and 1921 were in different vicinities, and the environmental flora differed somewhat in the two years.

LIST OF SPECIES TAKEN IN THE STATIONS

In the following pages scarcely more than extreme dates of occurrence of most insects can be given. More detailed information is presented for the more significant species.

Neuroptera, Chrysopidae

Chrysopa oculata Say. 1920. E1-4, July 27, 1920. F1-5, Aug. 4-Sept. 7. Plentiful, only adults, hence probably migrated to soybeans. One brood per year.

*Thanks are due Professors Herbert Osborn, Jas S Hine, and D M DeLong of the Ohio State University for assistance in determining the insects considered in this paper, to Professor Osborn also for advice on various features of the work

Orthoptera, Acrididae

Melanoplus femur-rubrum DeG. and *M. atlanis* Riley. 1920. E1, June 26-Aug. 20. E2, July 12-Sept. 7. E3, June 26-Sept. 7. E4, July 12-Aug. 11. F1, July 12-Sept. 27. F2, June 26-Sept. 7. F3, June 26-Sept. 7. F4, June 26-Aug. 20. F5, July 12-Sept. 27. Nymphs, June 26-Sept. 7, abundant in or near E1-3; fewer as season progressed. Adults, Sept. 7-27, few in F5.

1921. E1, June 22-Sept. 9. E2, June 22-Aug. 8. E3, June 22-Aug. 24. E4, June 22-Aug. 24. F1, June 22-Sept. 9. F2, June 22-Sept. 9. F3, June 22-Sept. 9. F4, June 22-July 26. F5, June 22-Sept. 9. Nymphs, June 22-Aug. 4; most in E early in season, most in F later: migrated to crop from E, or breeding ground. Adults, Aug. 24-Sept. 9. More common in F5 than in 1920.

Chortophaga viridifasciata DeG. 1920. F1, 3, Sept. 7. Three. More on soybeans in 1919.

1921. E1, 3, 4, July 14-Aug. 8. F1, Sept. 9. Adults. Few.

Arphia xanthoptera Germ. 1920. E1-4, July 12-Aug. 20. Ten nymphs.

Spharagemon bolli Scudd. 1920. F4, Aug. 4. One.

Dissosteira carolina L. 1920. F1, Aug. 20. One.

TETTIGONIIDAE

Conocephalus brevipennis Scudd., *C. strictus* Scudd., *C. vulgare*. 1920. E1-4, June 26-Sept. 27. F1-5, June 26-Sept. 7. Nymphs, June 26-Aug. 20. Migrated from E to F. Few in E4. Adults, Aug. 20-Sept. 27. Most from E. Fewer later.

1921. E1-4, June 22-Sept. 9. F1-5, June 22-Sept. 9. First adults, Aug. 8, or twelve days earlier than in 1920.

GRYLLIDAE

Oecanthus niveus DeG. 1920. E1-4, July 12-Sept. 27. F1-5, July 12-Sept. 27. Adults, Aug. 11-Sept. 27. Most from E, but numerous in F3, Aug. 4-20. Common.

1921. E1-4, July 14-Aug. 24. F1-5, June 22-Sept. 9. Adults, July 26-Sept. 9, or two weeks earlier than in 1920. Equal in E and F stations. Few.

HOMOPTERA, CICADELLIDAE

Empoasca mali LeB. 1920. E1-4, June 26-Sept. 27. F1-5, June 26-Aug. 20. Most plentiful species taken then. Majority on soybeans. Climax numbers, E, July 20-Aug. 11; F, July 12-Aug. 4.

1921. E1-4, June 22-Aug. 24. F1-5, June 22-Sept. 9. Numerous in F. Climax numbers, June 22-July 26, when soybeans were tender. Fewer than in 1920.

Agallia constricta VanD. 1920. E1-4, June 26-Aug. 20. F1-5, June 26-Sept. 7. Most from E1 and F1; plentiful also in E3 and 4 on grasses. No grasses in E2, hoppers few. At climax, E, July 2-26; F, July 2-26. Migrated from E to F.

A. sanguinolenta Prov. 1920. E1-4, June 26-Sept. 7. F1-5, June 22-Aug. 8. Fairly common all season in F. More in E3 than in any other E station. Few in E4.

1921. E1-4, June 22-Sept. 9. F1-5, June 22-Aug. 8. From 0-10 in E on each collecting date. Most from E; only twenty-three from F.

A. novella Say. 1920. F2, Aug. 20. One.

Draeculacephala mollipes Say. 1920. E1-4, June 26-Sept. 27. F1-5, June 26-Sept. 27. Not taken in every station and date.

1921. E1-4, June 22-Sept. 9. F1-5, June 22-Sept. 9. Most in E4, majority in the grassy E stations. Distinctly more plentiful than in 1920.

Chlorotettix viridius Van D. 1920. E, June 26-Sept. 27. F, June 26-Sept. 7.

1921. E, June 22-Sept. 9. Majority in E stations, most in E3. Few both years.

Platymetopius frontalis Van D. 1920. E, June 26-Sept. 27. F, July 12-Sept. 27. Majority in E. On ragweed in E4. 1-10 per date and station in F.

1921. E, June 22-Sept. 9. F, June 22-Sept. 9. Twenty-five taken in F1, Aug. 24. Otherwise fewer. Majority in E. Numbers increased after July 26.

P. acutus Say. 1920. E3, July 20. F3, July 12. Very few.

Thamnotettix nigrifrons Forbes. 1920. E, June 26-Sept. 27. F, July 12-Sept. 27. Fifteen from F, probably on Panicum. Otherwise fewer.

1921. E1-4, June 22-Sept. 9. F1-5, June 22-Sept. 9. Most in E1, Aug. 24 and Sept. 9 and in F1, Aug. 24. Majority in E. More than in 1920.

Deltocephalus inimicus Say. 1920. E, June 26-Sept. 27. F, Same. Few.

1921. E1-4, June 22-Sept. 9. F1-5, June 22-Sept. 9. Most in grassy E1 and 3, and in contiguous F1 and 3. At climax, June 22 in all stations excepting E3. Climax numbers here, Aug. 8. Many. Eighty percent in E.

D. flavicosta Stal. 1920. E, June 26-Sept. 7. F, June 26-Aug. 11. Subcommon.

1921. E1-4, June 22-Sept. 9. F1-5, June 22-Sept. 9. A distinct grass feeder. Climax numbers strikingly on Sept. 9 in all stations. Common to plentiful in E1, 3, 4, July 26-Sept. 9.

D. obtectus O. & B. 1920. F2-4, June 26-July 20. Five taken.

1921. E, June 22-Aug. 24. F5, July 26 and Sept. 9. Fifteen in E. Few also in F5.

D. striatus L. 1921. One. Place (E or F) not known.

Phlepsius irroratus Say. 1920. E, June 26-Sept. 27. F, July 12-Aug. 20. Most in E. Few.

1921. E, June 22-Sept. 9. F4, July 14. One. Few. Most in E.

Cicadula 6-notata Fall. 1920. E3, 4, June 26-July 20. F, July 12-Aug. 20. Climax numbers on July 20 in F4.

1921. E1-4, June 22-Sept. 9. F, June 22-Sept. 9. Most in E1, 3 and 4. One to sixty per date and station.

Kolla bifida Say. 1921. E, July 2-Sept. 9. F, June 22-Aug. 24. Ten from E, four from F.

Euscelis exitiosus Uhl. 1921. E, July 14-Sept. 9. Forty-six on Sept. 9. Nineteen on other dates.

E. striatulus Fall. 1921. One. Place (E or F) not known.

Acucephalus albifrons L. 1921. F2, July 2. F5, July 26. One each date.

Helochara communis Fitch. 1921. E1, June 22. One.

Scaphoideus immistus Say. Several from soybeans in 1919 and 1921.

Gypona octolineata Say. 1920. E, Aug. 4 and 11. Five.

1921. E, July 2 and 26. F1, 3 and 5, Aug. 8. Two in E, nine in F.

Parabolocratus viridis Uhl. 1920. E3, Aug. 4 and 11. F3, Aug. 11. Five.

Driotura gammaroides Van D. 1920. E2 and 3, July 20-Sept. 7. F2, July 2. Few.

Balclutha impicta Van D. 1920. F5, Sept. 9. Two taken.

Graphocephala coccinea Forst. 1920. F2, Sept. 7. Few.

1921. E1, Sept. 9. F1, 2, 4, Aug. 24 and Sept. 9. One or two each place and date.

Eutettix seminudus Say. 1920. F3, July 12. 1921. E1, July 14. One each year.

FULGORIDAE

Stobaera tricarinata Say. 1920. E, July 20-Sept. 7. F, July 12-Sept. 27. Subcommon.

1921. E, June 22-Sept. 9. F, June 22-July 2. Few.

Oliarus franciscanus Stal. 1920. E, June 26-July 27. F, July 12 and 20. Few. Eight in F3, July 12. 1921. E, June 22 and July 2. F, same. Few.

Liburnia campestris Van D. 1920. E, July 20-Aug. 20. F, July 12 and 20. Few. Most on earlier dates. 1921. E, June 22-Aug. 24. F, July 2 and 14. Few.

L. lutulenta Van D. 1920. E, July 20 and Aug. 4. F1, June 26. Three. Two from E.

L. puella Van D. 1920. E, July 20 and Aug. 20. Few.

1921. E, June 22-Aug. 24. F, July 2 and Aug. 24. Few.

L. pellucida Fabr. 1920. E1, June 26. One.

Liburniella ornata Stal. 1920. One, place (E or F) not known.

Scolops sulcipes Say. 1920. E1-3, July 12-Sept. 7. Ten in E3, Aug. 4.

1921. E, July 14-Aug. 24. F5, July 26. Few.

S. spurcus Uhl. 1920. E, July 20-Aug. 20. F1, Aug. 11. One to five.

Bruchomorpha oculata Newm. 1920. E3, June 26-Aug. 4. Four, July 27. Few.

1921. June 22. Three. Place (E or F) not known.

Acanalonia bivittata Say. 1920. F3, Sept. 7. One.

MEMBRACIDAE

Campylenchia curvata Fabr. 1920. E, July 12-Aug. 11. Five, E3, July 12. Few.

1921. E3, 4, July 2. Two taken.

C. latipes Say. 1920. E, July 12-Aug. 20. F3, Aug. 4. One each date.

1921. E, June 22-July 14. F1-4, July 2 and 14. Few.

Ceresa bubalus Fabr. 1920. E, July 20-Aug. 11. F, Aug. 4 and 11. One each date.

Micrutalis calva Say. 1920. F3, 5, June 26-Aug. 20. Two each date.

Enchenopa binotata Say. 1920. F5, July 20. One.

Phylloscelis atra Germ. 1920. E3, Aug. 20, Sept. 7. Four. 1921. E4, Aug. 24. One.

Acutalis tartarea Say. 1921. E2, Aug. 24. F4, Sept. 9. Two.

Lepyronia quadrangularis Say. 1920. E1, 2, July 20-Aug. 11. Two.

Clastoptera xanthocephala Germ. 1921. E1, Aug. 24. F5, same. Three.

HETEROPTERA, MIRIDAE

Lygus pratensis L. 1920. E1-4, June 26-Sept. 27. F1-5, same. Plentiful in E, common in F. In all stations on all dates. Migrated from E to F. Climax numbers: E, July 20, Sept. 7 and 27; F, July 27, Sept. 7. Probably from weeds in F5, Sept. 7.

1921. E1-4, June 22-Sept. 9. F1-5, June 22-Sept. 9. Majority again in E. Climax numbers: E, July 2 and 14; F, July 14 and 26.

Reuteroscopus ornatus Reut. 1920. E1-4, July 12-Sept. 27. F1-5, same. Plentiful in E from Aug. 11-Sept. 7. Few in F excepting on Aug. 20 and Sept. 7. Then subcommon. Associated with ragweed. One of the most common species.

1921. E, June 22-Sept. 9. F, same. Numbers correlated with quantity of weed food plants.

Adelphocoris rapidus L. 1920. E1-4, June 26-Sept. 27. F1-5, July 20-Sept. 27. About equal in E and F. Subcommon. Nymphs numerous on alfalfa, May 18. First adults developed May 28. Scarce after June 15 and in 1921.

1921. E, June 22-Sept. 9. F, same. Majority in E. Most (forty-three) from E3.

Mecomma sp. 1920. E, June 26-Sept. 27. F, June 26-Sept. 7. Climax numbers, E4, Sept. 7 (twenty-nine taken), and F1, Sept. 7 (eleven taken).

1921. E, June 22-Aug. 24. F, same. Majority from E. Climax in E and F, Aug. 24.

Lopidea media Say. 1920. E, July 12-Sept. 7. F, same. More from F.

1921. E, July 14. One.

L. robiniae Uhl. 1920. E1, July 12. F4, 5, July 20 and Aug. 4. Scarce.

Poeciloscytus basalis Reut. 1920. E, July 12-Sept. 27. F, July 12 and Sept. 7. Nine from E, four from F3. 1921. E3, July 2. One.

Ilnacora divisa Reut. 1920. E4, July 20-Sept. 7. F3, 4, Aug. 20-Sept. 7. Two from F, eight from E.

1921. E, June 22-Sept. 7. F2, 4, July 26 and Aug. 8. Always taken in E. Few.

Poecilocapsus sp. 1920. E1, Sept. 7 and 27. Fifty-two, Sept. 7. Three, Sept. 27.

Megaloceroea debilis Uhl. 1921. E2, July 2. One.

LYGAEIDAE

Orthaea basalis Dall. 1920. E1, 3, July 20-Sept. 27. F3, 4, July 20-Sept. 27. Few.

1921. E, July 2-Aug. 24. F1, 2, 5, July 14-Sept. 9. Ninety-three from E, three from F.

Phlegyas abbreviatus Uhl. 1920. E3, June 26-Sept. 7. Four, on timothy.

1921. E, June 22-Sept. 9. F, July 26 and Aug. 8. Twenty from E, four from F.

Geocoris uliginosis Say. 1920. E1, 3, July 20, Sept. 27. Two.

1921. E, July 2-Sept. 9. F, July 2-Sept. 9. Thirty from E, thirteen from F. Most from E2, the weediest station.

Lygaeus kalmi Stal. 1920. E1, July 20, Aug. 4. F3, July 14. Three.

Ligyrocoris diffusus Stal. 1920. E1, Sept. 7 and 27. F1, Aug. 11. Three.

1921. E4, Aug. 24. One.

Ptochiomera nodosa Say. 1920. E1, June 26, Aug. 11. Three. 1921. F1, July 2. One.

Aphanus umbrosus Dist. 1920. F5, July 20. One.

PENTATOMIDAE

Euschistua variolarius P. B. 1920. E, July 20-Aug. 20. F, July 20-Sept. 27. Few in E and F.

Podisus maculiventris Say. 1920. E, July 20-Sept. 27. F, July 12-Sept. 27. More in F.

Solubea pugnax Fabr. 1920. F5, Aug. 4. One. More present in 1919, on soybeans.

1921. E, July 14-Aug. 24. F, July 14-Sept. 9. Eleven in E, twenty-five in F.

Peribolus limbolarius Stal. 1920. E, July 20-Aug. 11. Three. 1921. F3, July 14. One.

Thyanta custator Fabr. 1920. F2, Aug. 20. One.

Nezara hilaris Say. 1920. F1, Aug. 20. Two.

Mormidea lugens Fabr. 1920. F2, Aug. 11. 1921. E3, July 14. One each year.

CORIMELINIDAE

Thyreocoris pulicarius Germ. 1920. E, June 26-Sept. 7. F3, 4, 5, July 12 and 20. Subcommon.

TINGITIDAE

Piesma cinerea Say. 1920. F1, 4, July 12. Three. Six from cucumber, June 7, 1919.

1921. E1, July 2. F1, 2, 4, July 2-Aug. 4. Four.

ANTHOCORIDAE

Triphleps insidiosus Say. 1921. E1, 2, July 2 and Aug. 4. F, July 2 and 14, Aug. 24. Forty-two taken, twenty from F3, July 2; eleven from F2, July 2.

REDUVIIDAE

Sinea diadema Fabr. 1920. E, June 26-Sept. 27. F, July 12-Sept. 27. Nineteen from E2, thirteen from E3. Fewer in other stations.

1921. E1, 2, 3, July 26-Sept. 9. F1, 2, 3, July 14-Sept. 9. Sixteen from E, Three from F.

NABIDAE

Nabis ferus L. 1920. E, July 27-Sept. 27. F, July 27-Sept. 7. Occasional.

1921. E, June 22-Sept. 9. F, June 22-Sept. 9. Nineteen from E, Fifty-five from F.

N. roseipennis Reut. 1920. E1, 2, 4, July 27-Aug. 4. F1, 3, 4, 5, July 12-27. Few.

1921. E1, 2, July 2, 26, and Sept. 9. F1-5, June 22-July 26. Few.

COLEOPTERA, CHRYSOMELIDAE

Nodonota tristis Oliv. 1920. E, June 26-Aug. 20. F, same. Most in E, on weeds.

1921. E, June 22-Aug. 24. F, July 2-Aug. 8. As in 1920. Common.

Systena taenata Say. 1920. E1-4, June 26-Sept. 9. F1-4, June 26-Sept. 9. None in F5. Climax numbers Aug. 4-Sept. 7. Twenty-seven from F, one hundred and nineteen from E during season. Fifteen from F3, June 26.

1921. E1-4, July 14-Sept. 1. F1-5, June 22-Aug. 8. Climax numbers, July 26-Aug. 8. Two hundred and fifty-eight from E, thirty-eight from F on July 26. Fifty from F, four hundred and seventy-one from E during season. Probably two broods represented each year.

S. hudsonias Forst. 1920. E, June 26-July 27. F, same. Climax numbers, June 26. Sixty-one from E, seventeen from F. Only one brood represented.

1921. E, June 22-July 14. F, June 22-Aug. 8. Eleven.

Epitrix cucumeris Harr. 1920. E1-4, June 26-Aug. 20. F2-5, July 12-Aug. 11. Two taken June 26. One hundred and thirty-two from E, three hundred and fourteen from F, on July 12; none in any station, July 27. Only twenty from all stations, Aug. 4-20. Most from E3 and F3, July 12. Fifty from E3, two hundred and seventy-five from F3.

1921. E1-4, June 22-Sept. 9. F1-5, same. Uniformly plentiful in E, June 22-Aug. 24. Climax numbers from F, June 22 and July 2. Few and irregular later, except in F1.

Colaspis brunnea Fabr. 1920. E, July 12-Aug. 11. F, June 26-Aug. 11. Fourteen from E, four hundred and sixty from F, during the season. Climax numbers, July 12 and 20.

1921. E, June 22-Aug. 8. F, June 22-July 26. Only one on Aug. 8 in E4. Fifty-three from E, probably from timothy and clovers. Ninety-one from F. Climax numbers, July 2-14.

Paria canella Fabr. 1920. E, June 26-Aug. 20. F, two. A distinct weed feeder. Common in E3, on weeds. Climax numbers, June 26-July 12.

1921. E1, 2, July 2 and 26. Two. Host plants rare.

P. sellata Horn. 1921. F1, June 22. One.

Cryptocephalus venustus Fabr. 1920. E, June 26-Aug. 11. Subcommon. Most in E3. At climax, June 26-July 20. 1921. E3, 4, June 22-July 26. Three.

Bassareus brunnipes Oliv. 1921. E, several.

Zygogramma suturalis Fabr. 1920. E, July 20-Sept. 27. F, Aug. 11-Sept. 27. Subcommon. On weeds.

1921. E2, 3, June 22-Aug. 24. F1, 2, 4, 5, June 26-Sept. 9. Eight from E, ten from F.

Diabrotica 12-punctata Oliv. 1920. In all E stations, but more in F.

1921. E, June 22-Sept. 9. F, same. Sixteen in E (on clovers), Seventy-six in F.

D. vittata Fabr. 1920. July 12-Sept. 27. Not plentiful. Chiefly in F.

1921. E, June 22-Sept. 9. F, June 22-Aug. 24. None in F2. Eighteen in E1 and 3, near cucumber fields. Twenty-three from F.

D. longicornis Say. 1921. E3, July 14 and Aug. 8. E4, Aug. 8 and Sept. 9. F2, Aug. 8 and 24. Three from E, four from F.

Phyllotreta sinuata Steph. 1920. E1, July 12. E3, July 20. Few.

P. vittata Fabr. 1920. F2, June 26. Scarce.

P. bipustulata Fabr. 1920. E1, July 12. F3, same. Few.

Graphops pubescens Melsh. 1920. E1, July 12. E2, June 26. Few.

Disonycha triangularis Say. 1920. F3, Aug. 11. Few.

D. glabrata Fabr. 1920. F1, July 12. F4, Aug. 11. F5, July 12. Few. On *Amaranthus*.

1921. E4, July 27, Aug. 24, Sept. 9. F1, June 22, Aug. 24. Six on E4, Sept. 9. Four in other stations.

D. mellicollis (?) Say. 1920. One taken.

Haltica ignita Ill. 1920. E2, Aug. 11. One.

Chaetocnema denticulata Ill. 1920. E, July 20-Sept. 27. None on E1. F, Aug. 11-Sept. 7. Few.

1921. E, June 22-Sept. 9. F, July 2-Aug. 24. Eighty-six from E, twelve from F. At climax on July 14 and 26.

C. pulicaria Melsh. 1920. E2, Aug. 20, E3, July 20, Aug. 4, 11 and 20. F, June 26-Aug. 20. One to twelve daily. Most from August 11-20.

Microrhopala vittata Fabr. 1920. E2, Aug. 4. One.

Longitarsus melanurus (?) Melsh. 1921. One.

Pachybrachs luridus Fabr. and *P. atomarius* Melsh. 1920. One each in E3.

P. hepaticus Melsh. and *P. othonus* (?) Say. 1920. Few. From weeds.

Lema trilineata Oliv. 1920. E1, June 26, July 27. F1, July 12. F5, Aug. 4. Few.

Coptocycla bicolor Fabr. 1920. E1-3, June 26-Aug. 11. Few.

C. signifera Herbst. 1920. E2-3, June 26-July 12. F1, July 20, Aug. 4. Few.

Cassida bivittata Say. 1920. E1-2, July 12-Aug. 20. F1-2, July 20-Aug. 11. Few.

Chalepus dorsalis Thumb. 1919. June 19, from soybeans. 1920. June 6. Same.

C. nervosa Panz. 1921. One from soybeans.

Cerotoma trifurcata Forst. 1920. From soil, Apr. 28; alfalfa, May 18; garden beans, May 31; string beans and soybeans, June 4-24. F5, Ang. 4. Few.

1921. F1, July 14. F2, July 26, Sept. 7. F3, July 26. F5, June 22, Sept. 9. Eight taken.

ELATERIDAE

Monocrepidius vespertinus Fabr. 1920. F1-5, July 12-Aug. 11. Larvae reported (12) from bean roots.

M. lividus DeG. 1920. F1-3, July 27-Aug. 11. Few. Five from a small area in a soybean field, June 27, 1919.

1921. E4, Aug. 24. F1, July 2. Generally common in other situations.

M. auritus Herbst. 1920. E3, June 26. One.

MELOIDAE

Epicauta vittata Fabr. 1920. F4, July 27. One. 1919, Aug. 5, common on *Amaranthus*.

E. marginata Fabr. 1920. E3, July 20. F2, 3, 5, July 20-Sept. 7.

1921. E3, July 2. One.

E. pennsylvanica DeG. 1920. E2, Aug. 20. One. 1919, Sept. 6. Common on *Amaranthus*.

Macrobasis unicolor Kirby. 1920. F4, July 12. Six on alfalfa, June 1 and 25. Numerous on garden beans, June 24, 1921.

CERAMBYCIDAE

Tetraopes tetraophthalmus Forst. 1920. E3, July 20. One. F2-4, July 20-Aug. 11.

Dectes spinosus Say. 1920. E4. F2-5. Eight taken Aug. 4-20.

1921. E2, July 14. E4, July 26. F1, July 26. F4, July 14 and 26. Seven taken.

Lepturges symmetricus Hald. 1920. E3, June 22. One.

MORDELLIDAE

Mordellistina morula Lec. 1920. E1-4, June 26-July 27. F1, 3, 4, July 20 and 27. Few.

1921. E1-4, June 22-July 26. F2, June 22. F5, July 14. Eight in E. Two in F.

M. pustulata Melsh. 1920. E1, July 27. E2, Aug. 4. F1, July 12. June 26, July 27.

1921. E2, July 2. E4, same. One each date.

EROTYLIDAE

Languria gracilis Newm. 1921. E3, July 2. One.

SCARABAEIDAE

Anomala lucicola Fabr. 1920. E2, July 12. One. F5, June 22. One.

A. undulata Melsh. 1919. Fairly common from soybeans in June.

BRUCHIDAE

Bruchus cruentatus Horn. 1920. F2, July 20. One.

1921. E2, July 2. F3, Aug. 24. Few.

B. obtectus Say. 1921. E2, July 2. F5, July 26. Three. Many from stored beans, May, 1920.

PHALACRIDAE

Phalacrus politus Melsh. 1920. E1 and 3, July 20. F1, 3, 4, 5, July 12-Aug. 11. Few.

1921. E1-4, June 22-Sept. 9. F1-5, July 2-Sept. 9. Subcommon. Also on corn smut.

COCCINELLIDAE

Coccinella 9-notata Herbst. 1920. E1 and 4, Aug. 11-Sept. 27. F1, 2, 4, 5, July 20-Sept. 27.

1921. E1, July 26 and Aug. 8. F4, July 14 and 26. Seven taken.

C. sanguinea L. 1920. E1-4, Aug. 4-Sept. 27. F1, 3, 4, July 20-Sept. 27. Never more than four.

1921. E1, 2, 4, July 14-Aug. 8. F1, 2, 3, July 14 and 26. Few.

Hippidamia parenthesis Say. 1920. E1-4, July 20-Sept. 27. F4, Aug. 4. F5, July 20 and 27.

1921. E1-3, July 2 and 14. F1, 2, 3, 5, July 2 and 14. Subcommon. Few in 1920.

H. convergens Say. 1920. F1, Aug. 11. One.

1921. E2, 4, July 2-14. F1, July 26-Aug. 8.

H. glacialis Fabr. 1921. E3, July 2. One.

Megilla maculata DeG. 1920. E4, July 27 and Sept. 27. F3, July 12. F5, July 20 and 27. 1921. E4, July 2 and Aug. 24. F1, same.

Brachyacantha ursina Fabr. 1920. E2, 3, 4, June 26-July 27. Scarce.

Psyllobora 20-maculata Say. 1920. One from soybeans.

Epilachna borealis Fabr. 1921. F3, July 14. One.

MALACHIIDAE

Collops quadrimaculatus Fabr. 1920. E1-3, June 26-Aug. 11. F1, 5, June 26-July 20. Few.

1921. E1-4, July 2-Sept. 9. F3, June 22. F5, Aug. 8. Ten from E, two from F. Twelve taken.

LAMPYRIDAE

Chauliognathus pennsylvanicus DeG. 1920. E2, July 20. F2, 3, Aug. 20 and Sept. 7. Few.

C. marginatus Fabr. 1920. E3, 4, July 12 and 20. F3 4, June 26 and July 20. Few.

1921. E2, 3, June 22 and Aug. 24. F1, 5, June 22-July 11. Few.

Ditemnus latilobus Blatch. 1920. E1, 2, 4, Aug. 4-20. One to five taken.

1921. E1, 3, Aug. 24. Seven taken.

CICINDELIDAE

Cicindela punctata Oliv. 1920. E2, July 12, Aug. 4. Two taken.

1921. E2, 3, July 2 and 14. F3, 5, July 14 and 26. One each date.

CARABIDAE

Lebia vittata Fabr. 1920. F3, July 27. One.

L. analis Dej. 1920. F4, Aug. 11.

L. Grandis Hentz. 1920. F1, July 27. One. 1921. F2, June 22. F5, July 14.

L. Scapularis Dej. 1921. One. *L. atriventris* Say. 1921. One.

ANTHICIDAE

Notoxus anchora Hentz. 1920. E1, June 26 and July 20. Three taken.

CURCULIONIDAE

Rhinoncus pyrrhopus Boh. 1920. E1-3, June 26-Aug. 11. F1-3, July 12-Aug. 11. Few.

1921. E1-4, June 22-Sept. 9. F1-5, June 22-Sept. 3. Forty-two from E, Thirty-four from F.

C. penicellus Herbst. 1920. F4, July 12. One.

Baris umbilicata Lec. 1920. E1, 2, 3, June 26 and July 12. Few.

1921. E1, July 12. One.

Sitona hispidula Fabr. 1920. E2, July 12. F5, Aug. 4. Two.

1921. E1, 4, July 2-14. F4, Sept. 9. Four.

S. discoidea Gyll. 1921. E2, June 22. One.

Lixus musculus Say. 1920. E2, July 12. One.

Hyperodes rotundicollis? Dietz. 1921. E1, Sept. 9. Two. E3, same. Four.

ANTHRIBIDAE

Brachytarsus sticticus Boh. 1920. F5, Sept. 7. Two. 1921. E4, July 2.

B. limbatus Say. 1921. E4, June 22. One.

LEPIDOPTERA, NOCTUIDAE

Platyhypena scabra Fabr. 1920. E1, 2, Aug. 4-Sept. 7. F1-5, July 27-Sept. 27.

1921. E1-4, June 22-Aug. 8. F1-5, June 22-Aug. 24. On clover in E.

HYMENOPTERA, TENTHREDINIDAE

Schizocerus bruniventris Cress. 1919. July 2, 8 and 23. Six taken.

NOMADIDAE

Triepiolus lunatus Say. 1921. E1 and 2, July 14. Three taken.

VESPIDAE

Polistes annularis L. 1921. F5, July 26. Predaceous on green clover worm, 1919.

P. rubiginosus LeP. 1920. One from a station.

BRACONIDAE

Aleiodes intermedius Cress. 1919. July 24. Reared from small green clover worm.

A. terminalis Cress. 1919. July 29. Two from soybeans.

ICHNEUMONIDAE

Therion morio Fabr. F1, July 2. One taken.

DIPTERA, SYRPHIDAE

Mesogramma marginata Say. 1920. E1, 4, July 12- Aug. 20. F1-5, July 20-Aug. 20.

1921. E1-4, June 22-Sept. 9. F1-5, June 22-Sept. 9. Majority from E.

M. polita Say. 1920. E1, 2, 4, July 27-Sept. 7. F1, 3, 4, 5, July 20-Aug. 20.

1921. E2-4, July 2-Sept. 10. F1, 3, 5, July 2-Sept. 9. One to four each date.

Syritta pipiens L. 1921. E1, July 14. One.

Platycheirus quadratus Say. 1921. F3, July 14. One.

ASILIIDAE

Deromyia umbrina Lw. 1920. F3, 4, July 27 and Aug. 20. Two.

1921. E3, Aug. 8. F2, July 26. F3, July 14. Subcommon. Feed on green clover worms.

D. discolor Loew. 1920. E4, Aug. 4. One. 1921. F3, 5, Aug. 24. Two.

Taracticus octopunctatus Say. 1920. E2, June 20-Aug. 11. F2, 3, July 12. Eight.

Erax rufibaris MacQ. 1920. F3, Sept. 7. A pair, taken mating.

SARCOPHAGIDAE

Sarcophaga altisterna Parker. 1920. F1, July 20. One.

S. bullata Parker. 1920. F5, Aug. 20. One.

1921. E1, July 26. E4, June 26. F1, Sept. 9. F5, same. One each date.

Sarcophaga quadrisetosa Coq. 1920. F5, Aug. 20. One.

S. opifera? Coq. 1920. E2, July 27. One.

TACHINIDAE

Hypostena barbata Coq. 1920. E1, Aug. 11. One. 1921. E2, 3, July 2.

Winthemia quadripustulata Fabr. 1920. F5, Sept. 7.

1921. F1, 2, 4, 5, July 26 and Aug. 8. Four.

Microphthalma disjuncta Wied. 1919. Aug. 8, from soybeans. One.

Gymnosoma fuliginosa Desv. 1919. One from soybeans.

Masicera celer Coq. 1921. One. Station unknown.

SAPROMYZIDAE

Sapromyza lupulina Fabr. 1919. July 8-Aug. 10. On soybeans.

1920. E2-4, June 26-Aug. 20. F4 and 5, July 20-Aug. 20. One to four per date.

1921. E1 and 4, July 14-Sept. 9. F2-5, June 26-Aug. 8.

S. verticalis Lw. 1920. F4, July 12. One.

DROSOPHILIDAE

Cyrtonotum helyum Lw. 1920. E2, July 12-Aug. 4. F1, 4, Aug. 4-11. Few.

1921. F5, July 2. One.

ANTHOMYIDAE

Hylemyia fusciceps Zett. 1920. F5, July 12. Three.

Hylemyia sp. 1920. F2, July 12. Seven.

ORTALIDAE

Tetanops integra L. W. 1920. E1, Sept. 27. F1-5, June 26-July 20. One to two.

1921. E1-3, June 22-July 26. F1-5, June 22-Aug. 8. Subcommon.

Chaetopsis aenea Wd. 1921. At least one.

TRYPETIDAE

Euaresta bella Lw. 1920. E1, Aug. 11. One. 1919. July 30, one from soybeans.

1921. E1-3, July 14-Aug. 24. F3 and 5, July 14-Aug. 24. One each date.

MUSCIDAE

Pseudopyrellia cornicina Fabr. 1920. E1, Sept. 27. F5, Aug. 4. Few.

EPHYDRIDAE

Paralimna appendiculata Lw. 1921. E1-4, June 22-Aug. 8. F1, June 22, Aug. 8. Few.

SUMMARY AND CONCLUSIONS

The species and families represented by the largest numbers taken in the stations during 1920 and 1921 are given in the summary list. They are the forms that were (1) significant factors as natural enemies, and (2) made the nearest approach to constituting pests. The families Cicadellidae, Fulgoridae, Miridae, and Chrysomelidae included 39 percent of all the species taken. It is estimated that these groups, together with the Acrididae, Tettigoniidae, and Noctuidae, or a total of seven families, embrace the species that composed 95 percent of the total individuals collected in the stations. The figures opposite the names in the list represent an estimate of the percentage of the chief species occurring on the soybeans and on the environmental flora.

WHY THE SOYBEAN HAS NO SERIOUS INSECT PESTS IN OHIO

Despite the two hundred and nine species taken on or near soybeans, this crop may be declared relatively free from insect pests of primary importance. The majority of forms taken occurred in small numbers and belong specifically to the environment where they developed and fed on weeds and grasses. Some of these weed- or grass-feeders were also swept from the soybeans. It can not be said that they were all feeding on the crop, but were usually only transients, roaming about in response to a natural impulse to be active. Others were present on their preferred weed- or grass-hosts that grew up among the soybeans.

FAMILIES AND SPECIES TAKEN IN LARGEST NUMBERS AT THE STATIONS IN 1920 AND 1921

Family	Genus	Species	Environmental flora	Soybeans
			Percent	*Percent*
Acrididae			40	60
Tettigoniidae			50	50
Cicadellidae	Empoasca	mali	30	70
	Agallia	constricta	70	30
	Agallia	sanguinolenta	70	30
	Draeculacephala	mollipes	65	35
	Thamnotettix	nigrifrons	75	25
	Deltocephalus	inimicus	80	20
	Deltocephalus	flavicosta	60	40
Miridae	Lygus	pratensis	60	40
	Reuteroscopus	ornatus	70	30
	Adelphocoris	rapidus	65	35
Chrysomelidae	Systena	taeniata	65	35
	Systena	hudsonias	75	25
	Epitrix	cucumeris	45	55
	Colaspis	brunnea	20	80
	Chaetocnema	denticulata	75	25
Coccinellidae	Coccinella	9-notata	20	80
	Coccinella	sanguinea	20	80
Noctuidae	Platyhypena	scabra	5	95
Asilidae	Deromyia	umbrina	5	95
Tachinidae	Winthemia	quadripustulata	0	100

Some of the species taken have miscellaneous food habits, and although they belonged in part to the environment, they were attracted to the crop to feed. It can not be gainsaid that such miscellaneously feeding species are responsible for a considerable general injury to the soybeans. The damage from this source is usually more severe than that from one or more potential pests. This fact, however, seems to be recognized with reluctance, if at all, because the large majority of these plant-feeding individuals are sucking forms whose damage is relatively inconspicuous until it becomes severe and then the curling or yellowing of the leaves is often mistakenly attributed to other causes. The devitalization sustained by the soybeans from this type of feeding is very considerable, and doubtlessly the final yield in hay or seed is materially lessened where such injury occurs.

Only 5 of the 16 plant-feeding species can be regarded as showing a preference for the soybean. The rest prefer weeds, or become widely scattered as they develop and multiply, so that their concentration in serious numbers on soybeans is prevented. Therefore, as long as abundant rainfall makes a plentiful growth of diverse food plants possible only minor damage may be expected to the crop from most of the phytophagous species listed.

There are more definite reasons, however, why the five rather populous potential pests have not become seriously menacing. *Empoasca mali* is found well distributed over many food plants, and its derogatory effect is therefore not generally extensive and often not fully appreciated. Furthermore, this general type of injury to field crops grown in large acreage has not come to be duly evaluated by growers. *Colaspis brunnea* is limited to one brood a year, hence does not multiply to numbers reached by species with two or more generations. The available supply of clover is never threatened by the green clover worm in the spring before the soybeans come up, hence food is not a limiting factor with this species. In 1920 distinctly fewer caterpillars were taken than in 1921. A mild winter and early spring preceded the 1921 season in which, the larvae rapidly developed to serious numbers, but parasites, and possibly fungous disease interfered with their further increase. This may suggest the factors limiting the green clover worm. *Winthemia quadripustulata* was at its height when the caterpillar decline began. It is possible that some other Diptera, the Coccinellidae and the Hymenoptera taken, and along with these, certain limiting climatic factors annually play significant parts in maintaining a check on this worst potential enemy of the soybean.

CONTROL BY CLEAN CULTURE

In practically all cases where a plentiful species was about equally distributed over Stations E and F, the infesting insects originated in the environment and subsequently migrated to the soybeans. In other words, the attack on the crop is sometimes due directly to the presence of the wild food plants in the surroundings. It seems that much may be done to prevent a large accumulated harm from the combined feeding of several such species by clean culture both in the field and in the environment. It is necessary to destroy both weeds and grasses by plowing and cultivation. Periodical mowing of these plants has only temporary, if any, value. Many insects occurring on such hosts have miscellaneous food habits, hence they spread readily to seek other food, and are as likely to migrate into the cultivated field as away from it. Furthermore, the environmental plants largely recover from the cutting, send out new succulent shoots, and become more attractive, especially to the Cicadellidae and Miridae, than they were just previous to the mowing. Great variety also characterizes these plants, which begin their growth, blossom and reach maturity at somewhat different times. Consequently, there is a more or less constant supply of food present in the environment to attract and retain the insects that feed on such plants and to a lesser or greater extent also on the soybeans.

An infestation may arise when the surplus individuals congregated in the environment overflow into the soybean field. This principle applies to other crops as well. There seems to be some basis for believing that a good proportion of our pests are primarily weed or grass feeders, and at times become a menace through migration on account of excess numbers, diminishing food supply, or loss of attractiveness of such food on account of maturity. The grasshoppers and *Systena hudsonias*, which develop in the soil and weeds, respectively, exemplify this fact. In most cases, such migration extends only to the field margins in large numbers.

FACTORS CAUSING FLUCTUATIONS AMONG INSECTS

Several groups of insects furnished examples of the relation the season and environment bear to their development and abundance. A distinctly greater number of Cicadellidae were present in 1921 than in 1920 on account of the quantity of grassy area about the soybean field, and likewise of the abundant rainfall which stimulated rank growth of the grasses. The composition of the

plant associations differed according to varying elevation of parts of the 1920 field, and between the two years, due to the extent to which the plant successions in the environments had progressed. The greater number of Chrysomelidae of 1920 originated from the various larval weed-hosts that occurred in plenty about the soybean field. The leafhoppers were relatively less plentiful in 1920 because grasses were few in the E stations.

The effect of season on the date of maturity of certain species was obvious. Some beetles and the Acrididae, Tettigoniidae, and *Oecanthus niveus* became adult from one to two weeks earlier in 1921 than in 1920.

Another marked phenomenon was the fluctuation in number of species and individuals noted between the E stations and the F stations, and within the several stations in one year. Some of the causal factors are the varying degrees of maturity or succulency of the host or food plants; the status of the physiological and especially the reproductive processes in the insects themselves; the number of broods each species develops annually, the number of individuals produced and the varying times in which the progeny of the several species occurs; the interference of fungous diseases and of both predaceous and parasitic insects.

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